Draft

Total Maximum Daily Load

Evaluation

for

Three Segments

in the

Satilla River Basin

for

Selenium

Submitted to:
The U.S. Environmental Protection Agency
Region 4
Atlanta, Georgia

Submitted by:
The Georgia Department of Natural Resources
Environmental Protection Division
Atlanta, Georgia

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EXECUTIVE SUMMARY

The State of Georgia assesses its water bodies for compliance with water quality criteria established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed water bodies are placed into one of three categories, supporting designated use, not supporting designated use, or assessment pending, depending on water quality assessment results. These water bodies are found on Georgia's 305(b) list, as required by that section of the CWA that defines the assessment process, and are published in *Water Quality in Georgia 2018-2019* (GA EPD, 2020). This document is available on the Georgia Environmental Protection Division (GA EPD) website.

The subset of the water bodies that do not meet designated uses on the 305(b) list are also assigned to Georgia's 303(d) list, named after that section of the CWA. Although the 305(b) and 303(d) lists are two distinct requirements under the CWA, Georgia reports both lists in one combined format called the Integrated 305(b)/303(d) List, which is found in Appendix A of *Water Quality in Georgia 2018-2019* (GA EPD, 2020). Water bodies on the 303(d) list are denoted as Category 5, and are required to have a Total Maximum Daily Load (TMDL) evaluation for the water quality constituent(s) in violation of the water quality standard.

The TMDL process establishes the allowable pollutant loadings or other quantifiable parameters for a water body based on the relationship between pollutant sources and in-stream water quality conditions. This allows water quality-based controls to be developed to reduce pollution and restore and maintain water quality.

A TMDL is defined as the sum of the individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources, as well as natural background (40 CFR 130.2) for a given waterbody. The TMDL must also include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the water quality response of the receiving water body.

The State of Georgia has identified three (3) coastal water segments located in the Satilla River Basin as impaired for selenium. The water use classification of the impacted streams is Fishing. The general and specific water quality criteria for Fishing streams are stated in the Water Use Classifications and Water Quality Standards section of the Georgia *Rules and Regulations for Water Quality Control*, Chapter 391-3-6-.03, Sections (5) and (6) (EPD, 2021).

Using the mass balance approach, the calculation of the selenium load at any point in a coastal stream requires the selenium concentration and flow. The listed steam segments are tidal in nature, and as such, the flow continuously varies, in both volume and direction. Therefore, selenium daily loads are represented by the variable flow (Q) (flow) times the measured selenium concentration, or in the case of the TMDL, the appropriate selenium criteria. The selenium load and required reduction for the listed streams are summarized in the table below.

Total Dissolved Selenium TMDL Summary for the Impaired Stream Segments in the Satilla River Basin

Stream Segment	Criteria	Current Load(1)	WLA(2)	WLA_{SW}	LA	MOS(1)	TMDL(1)	Reduction
Brunswick River	Acute	Q_{Total} x 9.82 x 10^{-1} kg/day	--	Q_{WLAsw} x 9.88 x 10^{-1} kg/day	Q_{LA} x 9.88 x 10^{-1} kg/day	Q_{Total} x 1.10^{-1} kg/day	Q_{Total} x 1.10 kg/day	0.0%
	Chronic	Q_{Total} x 9.82 x 10^{-1} kg/day Q_{Total} x 259.5 µg/L	--	Q_{WLAsw} x 2.42 x 10^{-1} kg/day	Q_{LA} x 2.42 x 10^{-1} kg/day	Q_{Total} x 2.69 x 10^{-2} kg/day	Q_{Total} x 2.69 x 10^{-1} kg/day	72.6%
Gibson Creek	Acute	Q_{Total} x 5.67 x 10^{-1} kg/day Q_{Total} x 149.7 µg/L	--	Q_{WLAsw} x 9.88 x 10^{-1} kg/day	Q_{LA} x 9.88 x 10^{-1} kg/day	Q_{Total} x 1.10^{-1} kg/day	Q_{Total} x 1.10 kg/day	0.0%
	Chronic	Q_{Total} x 5.67 x 10^{-1} kg/day Q_{Total} x 149.7 µg/L	--	Q_{WLAsw} x 2.42 x 10^{-1} kg/day	Q_{LA} x 2.42 x 10^{-1} kg/day	Q_{Total} x 2.69 x 10^{-2} kg/day	Q_{Total} x 2.69 x 10^{-1} kg/day	52.6%
Purvis Creek	Acute	Q_{Total} x 4.53 x 10^{-1} kg/day Q_{Total} x 119.8 µg/L	--	Q_{WLAsw} x 9.88 x 10^{-1} kg/day	Q_{LA} x 9.88 x 10^{-1} kg/day	Q_{Total} x 1.10^{-1} kg/day	Q_{Total} x 1.10 kg/day	0.0%
	Chronic	Q_{Total} x 4.53 x 10^{-1} kg/day Q_{Total} x 119.8 µg/L	--	Q_{WLAsw} x 2.42 x 10^{-1} kg/day	Q_{LA} x 2.42 x 10^{-1} kg/day	Q_{Total} x 2.69 x 10^{-2} kg/day	Q_{Total} x 2.69 x 10^{-1} kg/day	40.7%

(1) $Q_{Total} = Q_{LA} + Q_{WLAsw}$ (MGD)
(2) No permitted wastewater treatment facilities with selenium limits in watershed

1.0 INTRODUCTION

1.1 Background

The State of Georgia assesses its water bodies for compliance with water quality standards criteria established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed water bodies are placed into one of three categories, supporting designated use, not supporting designated use, or assessment pending, depending on water quality assessment results. These water bodies are found on Georgia's 305(b) list, as required by that section of the CWA that defines the assessment process, and are published in *Water Quality in Georgia 2018-2019 (*GA EPD, 2020*)*.

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The TMDL process establishes the allowable loading of pollutants or other quantifiable parameters for a water body based on the relationship between pollution sources and water quality conditions of the water body. This allows water quality-based controls to be developed to reduce pollution and restore and maintain water quality.

A TMDL is defined as the sum of the individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources, as well as natural background (40 CFR 130.2) for a given waterbody. The TMDL must also include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the water quality response of the receiving water body.

The State of Georgia has identified three segments in the Satilla River Basin as not supporting their designated use due to exceedances of water quality standards for selenium. Table 1 presents the streams in the Satilla River Basin included on the 2012 and 2016 303(d) lists for exceedance of the selenium criteria.

Table 1. Water Bodies Listed for Selenium in the Satilla River Basin

Reach ID	Water body	Segment	County	1st year on 303(d) list	Segment Length (miles)	Designated Use
GAR030702030211	Brunswick River	South Brunswick River to the St. Simons Sound	Glynn	2012	5	Fishing
GAR030702030202	Gibson Creek	Headwaters to the Turtle River (Brunswick)	Glynn	2016	2	Fishing
GAR030702030203	Purvis Creek	Headwaters to the Turtle River	Glynn	2016	2	Fishing

1.2 Watershed Description

The Satilla River Basin is located in the southeastern part of Georgia, occupying an area of approximately 3,940 square miles (EPD, 2002). The United States Geologic Survey (USGS) has divided the Satilla River Basin into three sub-basins, or Hydrologic Unit Codes (HUCs). These are numbered as HUCs 03070201 through 03070203. Figure 1 shows the location of the Satilla River Basin in Georgia, and Figure 2 shows the sub-basins of the Satilla River. Figure 3 shows the locations of the impaired stream segments within the Satilla River HUC 03070203 sub-basin.

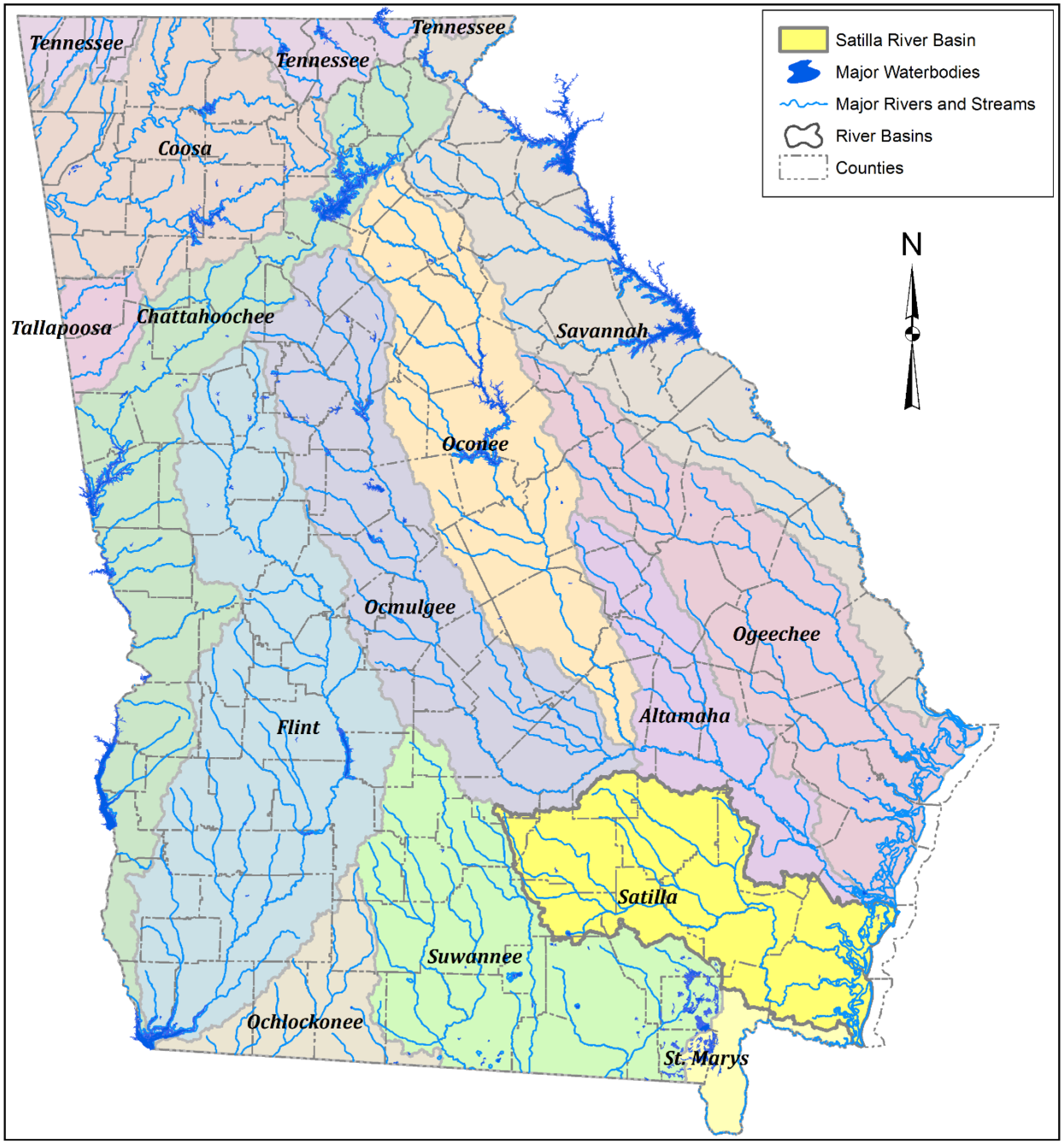


Figure 1. Location of the Satilla River Basin in the State of Georgia

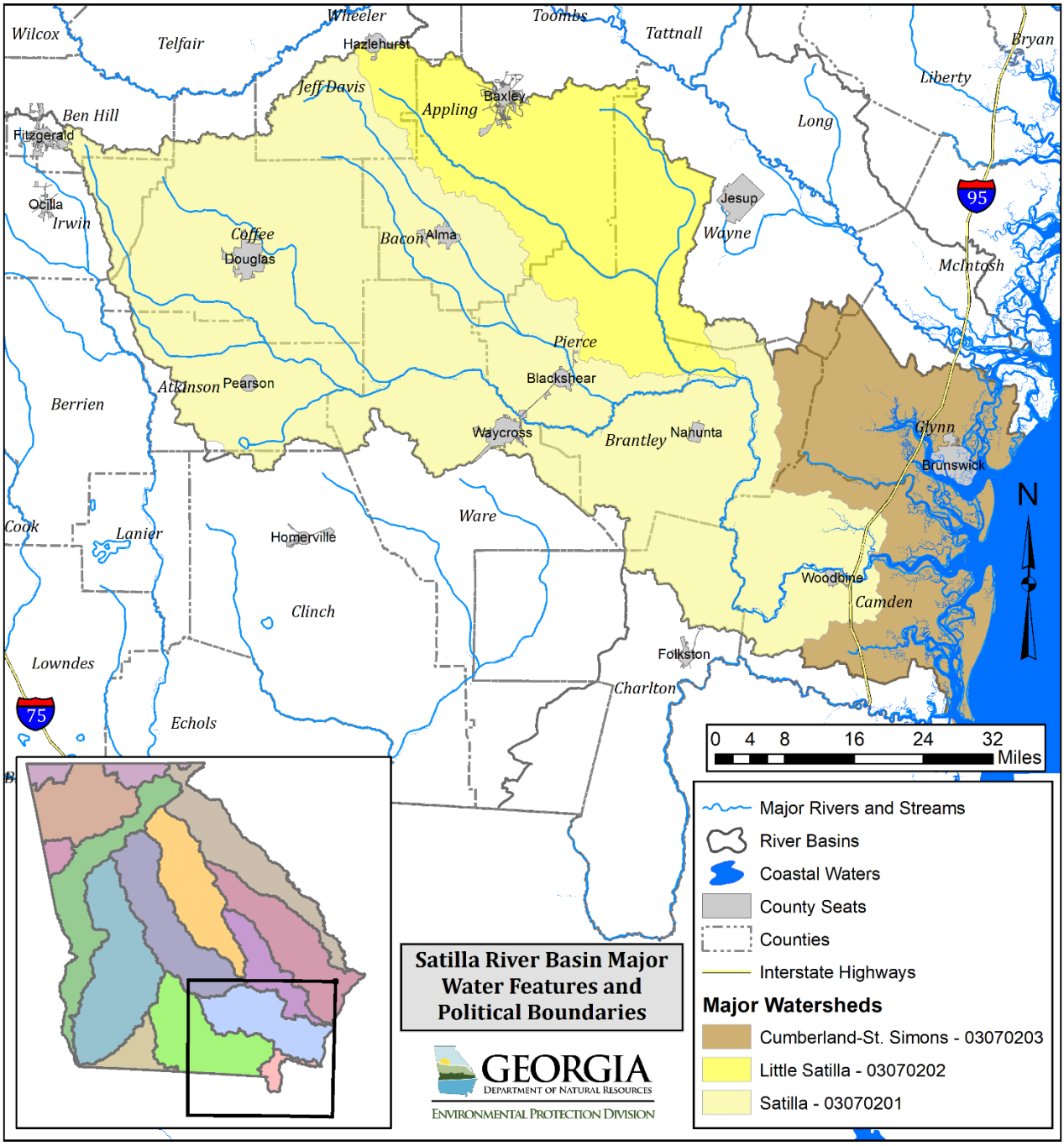


Figure 2. Location of the Three USGS 8-Digit Hydrologic Units of the Satilla River Basin

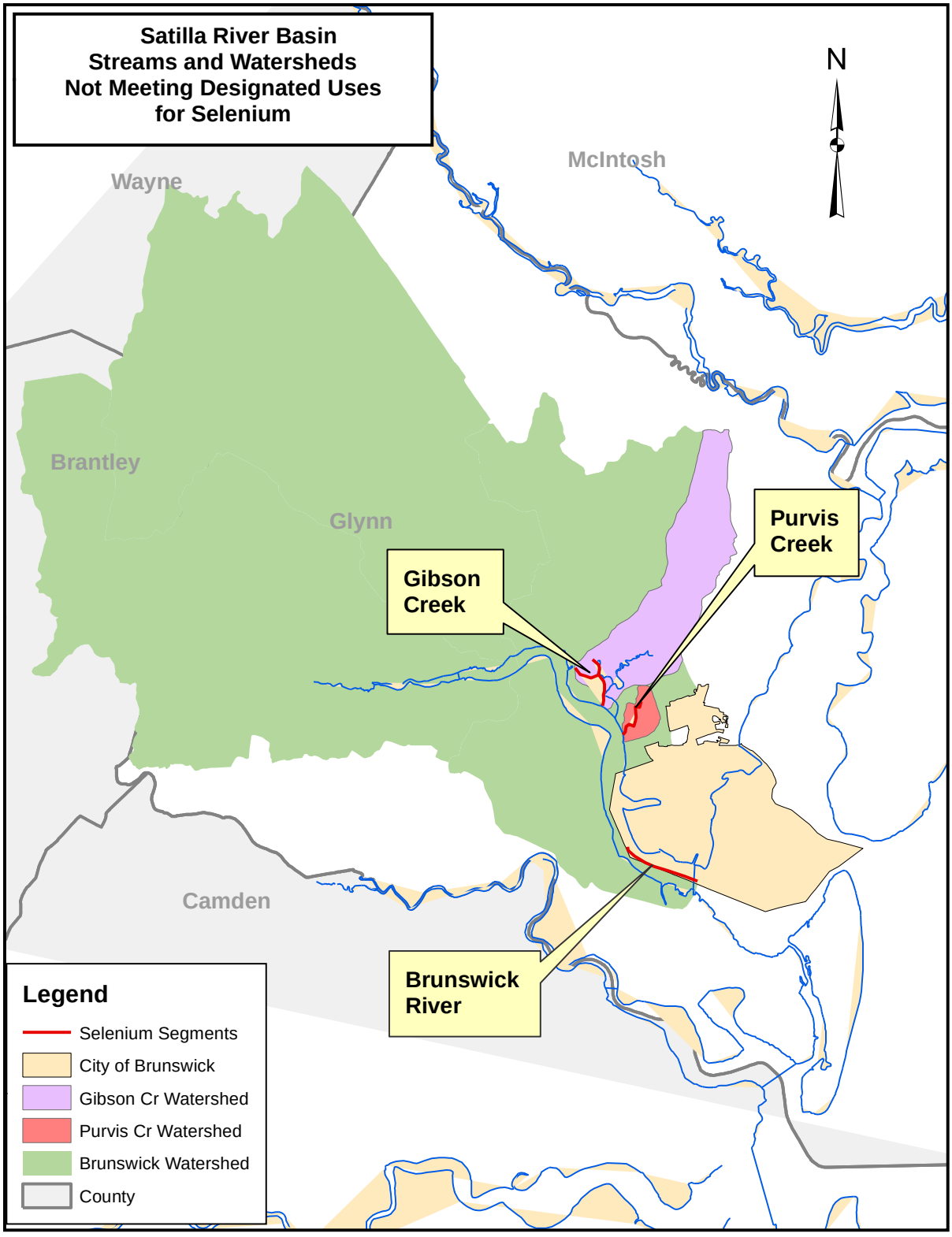


Figure 3. Location of the Three 303(d) Stream Segments Listed for Selenium in the Satilla River Basin

The headwaters of the Satilla River begin in Irwin County in south Georgia. Major cities in the Satilla River Basin include Douglas, Alma, Baxley, Jesup, Blackshear, Waycross, and Brunswick. The river is made up of Seventeen Mile Creek, Hog Creek, Alabaha River, and the Little Satilla River. The river flows southeast and eventually drains into the Atlantic Ocean just south of Brunswick.

The three non-supporting segments, the Brunswick River, Gibson Creek, and Purvis Creek are located in the Cumberland-St. Simons sub-basin (HUC 03070203). Both Gibson Creek and Purvis Creek are tributaries to the Turtle River northwest of the City of Brunswick. The Turtle River joins the South Brunswick River from the west, and the East River from the east to form the Brunswick River, approximately 6.5 miles downstream from the confluence of Purvis Creek. Both Gibson Creek and Purvis Creek are part of the Brunswick River watershed. These water bodies form an estuarine system expected to have similar water quality characteristics due to their close connectedness.

The land use characteristics of the Satilla River Basin watersheds were determined using data from the Georgia Land Use Trends (GLUT) for Year 2008. This raster land use trend product was developed by the University of Georgia – Natural Resources Spatial Analysis Laboratory (NARSAL) and follows land use trends for years 1974, 1985, 1991, 1998, 2001, and 2005. The raster data sets were developed from Landsat Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+). Some of the NARSAL land use types were reclassified, aggregated into similar land use types, and used in the final watershed characterization. Table 2 lists the watershed land use distribution for the drainage areas of the three stream segments.

1.3 Regional Water Planning Councils

The 2008 Comprehensive State-wide Water Management Plan established Georgia's ten Regional Water Planning Councils (RWPCs). The boundaries of these ten RWPCs, in addition to the Metropolitan North Georgia Water Planning District or MNGWPD, established under a separate statute, are shown in Figure 4. The three listed segments are located within the boundaries of the Coastal Georgia Regional Council. In 2011, each RWPC developed and adopted Regional Water Plans, which identify ranges of actions or management practices to help meet the State's water quality challenges. The MNGWPD and each RWPC subsequently updated and revised their respective management plan documents in 2017.Implementation of these plans is critical to meeting Georgia's water resource challenges.

1.4 Water Quality Standards

The water use classification for the listed coastal stream segments in the Satilla River Basin is Fishing. The Fishing classification, as stated in Georgia's Rules and Regulations for Water Quality Control Chapter 391-3-6-.03(6)(a) (EPD, 2021), is established to protect "Propagation of Fish, Shellfish, Game and Other Aquatic Life; secondary contact recreation in and on the water; or for any other use requiring water of a lower quality."

Chapter 391-3-6-.03(5)(e)(ii) of Georgia's Rules and Regulations establishes criteria for selenium that apply to coastal and marine estuarine waters in the State. The established saltwater acute and chronic criteria for dissolved selenium are as follows:

acute criteria for dissolved selenium = 290 µg/L
chronic criteria for dissolved selenium = 71 µg/L

Table 2. Satilla River Watersheds Land Cover Distribution

Stream/Segment	Land Use Categories - Acres (Percentage)													
	Open Water	Low Intensity Residential	High Intensity Residential	High Intensity Commercial, Industrial, Transportation	Bare Rock, Sand, Clay	Quarries, Strip Mines, Gravel Pits	Transitional	Forest	Row Crops	Pasture, Hay	Other Grasses (Urban, recreational; e.g. parks, lawns)	Woody Wetlands	Emergent Herbaceous Wetlands	Total
Brunswick River	7,357	5,222	1,924	1,826	816	173	12,285	74,338	3,564	755	11,367	43,713	14,567	177,905
	(4.1%)	(2.9%)	(1.1%)	(1.0%)	(0.5%)	(0.1%)	(6.9%)	(41.8%)	(2.0%)	(0.4%)	(6.4%)	(24.6%)	(8.2%)	(100.0%)
Gibson Creek	232	1,210	509	346	81	0	437	2,505	355	83	1,506	1,411	600	9,277
	(2.5%)	(13.0%)	(5.5%)	(3.7%)	(0.9%)	(0.0%)	(4.7%)	(27.0%)	(3.8%)	(0.9%)	(16.2%)	(15.2%)	(6.5%)	(100.0%)
Purvis Creek	38	74	51	20	11	0	0	58	13	1	123	3	449	840
	(4.5%)	(8.8%)	(6.0%)	(2.4%)	(1.3%)	(0.0%)	(0.0%)	(6.9%)	(1.5%)	(0.1%)	(14.6%)	(0.4%)	(53.5%)	(100.0%)

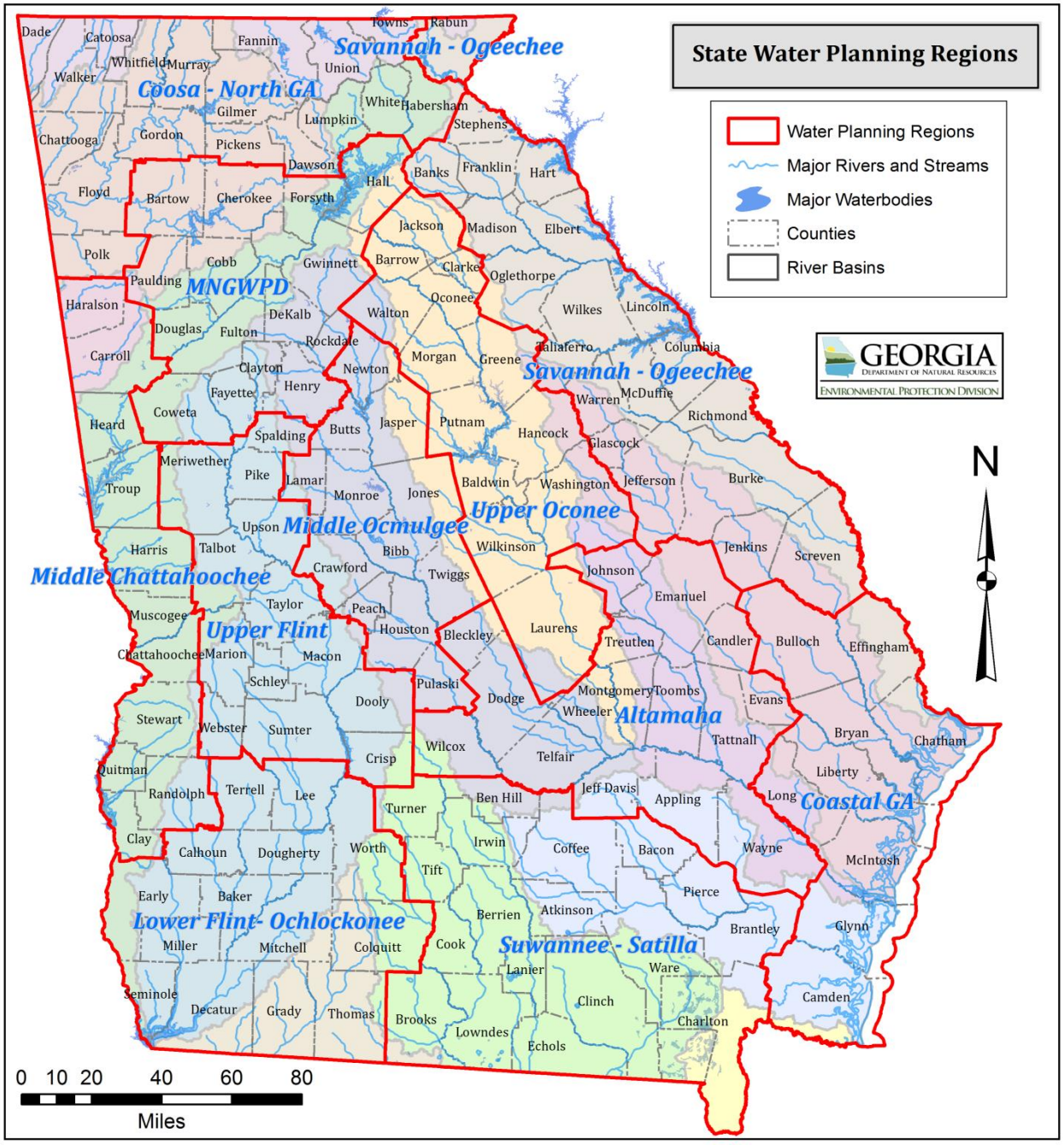


Figure 4. Boundaries of the Regional Water Planning Councils and the Metropolitan North Georgia Water Planning District

The instream criteria for selenium are expressed in terms of the dissolved fraction in the water column. In accordance with Georgia Rules and Regulations for Water Quality Control 391-3-6-.03(5)(e)(ii), EPA guidance was followed (EPA, 2004) for converting sample values given as total recoverable selenium to dissolved selenium using the conversion factor of 0.998.

In addition, Georgia Regulation 391-3-6-.06(4)(d)5.(ii)(b)(2) allows methods from this EPA guidance document to be used to translate dissolved criteria concentrations into total recoverable permit limits. Selenium effluent permit limitations are required to be expressed as total recoverable metal per 40 CFR §122.45(c). Therefore, the TMDL will be expressed as both the acute and chronic total recoverable selenium that will be protective of the dissolved selenium chronic and acute criteria.

1.5 Background Information for Selenium

Selenium is a naturally occurring, non-metallic element present in sedimentary rocks, shales, coal, phosphate deposits, and soils (EPA, 2016). The geochemistry of selenium is similar to that of sulfur. Selenium-containing minerals are rare, but it is more widely present as an element sometimes replacing sulfur in common sulfide minerals such as pyrite and chalcopyrite (Saliminen, 2005). It also occurs together with sulfides of metal such as copper, zinc and lead. The mobility of selenium in water increases under oxidizing conditions, and as pH increases from slightly acidic to more alkaline conditions. In solution, selenium primarily occurs as the anions of selenite (SeO_3^{-2}) and selenate (SeO_4^{-2}).

Selenium is an essential nutrient in small amounts for most animals including humans (EPA, 2016). It is required for growth and fertility in animals. Deficiencies in the human diet can lead to cardiomyopathy (Keshan Disease), and tubular bone changes (Kashin-Beck Disease). The dietary range requirement in humans is narrow and can become toxic at higher levels. Toxic effects in humans include hair and nail loss, skin disorders, abdominal cramps, and nerve damage. Selenium poisoning can become so severe as to cause death (Saliminen, 2005). Selenium bioaccumulates in the aquatic food chain. Chronic exposure to fish and aquatic invertebrates can cause reproductive impairments, larval deformities, or mortality (EPA, 2016; Luoma and Presser, 2009).

Selenium enters waterways by natural sources such as weathering of surface rocks and soils. Elevated concentrations in groundwater sometimes occur by leaching processes, especially where marine shales are present (Larry Walker Associates, 2006). Several anthropogenic sources have been identified including surface mining/extraction activities, atmospheric deposition from coal-fired power plants, industrial discharges, and to a lesser extent domestic wastewater treatment discharges. Drainage from irrigation practices in agricultural areas can increase selenium in surface waters where selenium-enriched ground water is used. This occurs directly from drainage off irrigated lands, and through remobilization by leaching from soils where long-term irrigation has occurred.

2.0 WATER QUALITY ASSESSMENT

Three impaired stream segments in the Satilla River Basin were determined to be not supporting their designated uses due to selenium based on water quality samples collected by the Georgia Environmental Protection Division (EPD) Watershed Planning and Monitoring Program. A stream segment is placed on the 303(d) list when any sample exceeds the acute criterion within a three year period or more than one sample exceeds the chronic criterion within a three year period.

The water quality data for the listed segments are provided in Table 3. In order to compare the measured data with Georgia's instream water quality standards, the total recoverable selenium values must be transformed to estimated equivalent dissolved concentrations using a conversion factor of 0.988 according to EPA guidance (EPA, 2004). Table 3 includes the total recoverable selenium, the calculated dissolved selenium concentrations, and indicates if the selenium sample values exceeded the Georgia saltwater acute criterion of 290 µg/L or chronic criterion of 71 µg/L.

Twenty-three samples were collected from the Brunswick River between the years 2010 through 2015 at the U.S. Highway 17 Bridge located south of Brunswick, GA. Selenium concentrations exceeded the chronic criterion in nineteen of these samples. No exceedances of the acute criterion were observed (Table 3).

Three selenium samples were collected from Gibson Creek in 2014 at a location immediately east of I-95, near the west side of Brunswick, GA. Two of the three samples exhibited selenium values greater than the chronic criterion (Table 3). No samples exceeded the acute criterion.

Purvis Creek was sampled for selenium on three occasions in 2014 at the end of an access road located west of Brunswick, GA. Of the three samples, two exceeded the selenium chronic criterion, while no samples exceeded the acute criterion (Table 3).

The measured exceedances of the selenium chronic criterion in samples collected in the Brunswick River resulted in this stream segment being placed on Georgia's 2012 303(d) list (EPD, 2010-2011). The measured exceedances of the selenium chronic criterion in samples collected in Gibson Creek and Purvis Creek resulted in these two stream segments being placed on Georgia's 2016 303(d) list (EPD, 2014-2015).

Table 3. Selenium Data Collected from Satilla River Basin

Location	Date	Measured Total Recoverable Selenium (µg/L)	Corresponding Dissolved Selenium (µg/L)	Exceeds Acute Criterion (µg/L)	Exceeds Chronic Criterion (µg/L)
Brunswick River					
U.S. Highway 17, South of Brunswick, GA (SH_07_3036)	03/18/2010	51	50.9	No	No
	06/02/2010	200	199.6	No	Yes
	09/16/2010	190	189.6	No	Yes
	12/16/2010	190	189.6	No	Yes
	03/16/2011	160	159.7	No	Yes
	06/16/2011	260	259.5	No	Yes
	09/20/2011	200	199.6	No	Yes
	12/13/2011	170	169.7	No	Yes
	03/07/2012	220	219.6	No	Yes
	06/14/2012	140	139.7	No	Yes
	09/13/2012	120	119.8	No	Yes
	12/04/2012	160	159.7	No	Yes
	03/06/2013	150	149.7	No	Yes
	06/12/2013	190	189.6	No	Yes
	09/09/2013	120	119.8	No	Yes
	03/04/2014	110	109.8	No	Yes
	06/09/2014	ND	ND	No	No
	9/15/2014	190	189.6	No	Yes
	12/8/2014	66	65.9	No	No
	03/30/2015	130	129.7	No	Yes
	06/09/2015	160	159.7	No	Yes
	09/08/2015	96	95.8	No	Yes
	12/09/2015	35.5	35.4	No	No
Gibson Creek					
East of I-95 Near Brunswick, GA (RV_07_3058)	6/25/2014	100	99.8	No	Yes
	9/15/2014	150	149.7	No	Yes
	12/8/2014	52	51.9	No	No
Purvis Creek					
Access Road West of Ross Road, Near Brunswick, GA (RV_07_3031)	6/25/2014	120	119.8	No	Yes
	9/15/2014	120	119.8	No	Yes
	12/8/2014	49	48.9	No	No

ND = Not Detected

3.0 SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of the potential sources of pollutants. A source assessment characterizes the known and suspected sources of selenium in the watershed. Sources are broadly classified as either point or nonpoint sources. A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Nonpoint sources are diffuse, and generally, but not always, involve accumulation of pollutants on land surfaces that wash off as a result of storm events.

3.1 Point Source Assessment

Title IV of the Clean Water Act establishes the National Pollutant Discharge Elimination System (NPDES) permit program. There are two basic categories of NPDES permits: 1) municipal and industrial wastewater treatment facilities, and 2) regulated storm water discharges.

3.1.1 Wastewater Treatment Facilities

In general, municipal and industrial wastewater treatment facilities have NPDES permits with effluent limits. These permit limits are either based on Federal and State effluent guidelines (technology-based limits) or on water quality standards (water quality-based limits).

The United States Environmental Protection Agency (USEPA) has developed technology-based guidelines, which establish a minimum standard of pollution control for municipal and industrial discharges without regard for the quality of the receiving waters. These are based on Best Practical Control Technology Currently Available (BPT), Best Conventional Control Technology (BCT), and Best Available Technology Economically Achievable (BAT). The level of control required by each facility depends on the type of discharge and the pollutant.

The USEPA and the States have also developed numeric and narrative water quality standards. Typically, these standards are based on the results of aquatic toxicity tests and/or human health criteria and include a margin of safety. Water quality-based effluent limits are set to protect the receiving stream. These limits are based on water quality standards that have been established for a stream based on its intended use and the prescribed biological and chemical conditions that must be met to sustain that use.

For purposes of this TMDL, NPDES permitted wastewater treatment facilities are considered point sources, and include municipal, industrial, private, and Federal facilities. Currently, there are 2 NPDES permitted industrial wastewater treatment facilities located within the Gibson Creek watershed, no NPDES permitted facilities located within the Purvis Creek watershed, and 12 facilities located within the Brunswick River tidal watershed, 6 of which are municipal facilities and 6 that are industrial. None of these facilities have permit limits that include selenium or selenium compounds, and these facilities are not considered sources of selenium for the impaired stream segments.

Georgia Power recently retired Plant McManus, an oil-fired power generating facility, located near Burnett Creek, a tributary to the Turtle River. As part of the facility's NPDES discharge permit (GA0003794), it is currently discharging under an approved Ash Pond Dewatering Plan. It began pond dewatering operations in early 2017. The discharge from the pond and Burnett Creek upstream and downstream from the discharge are sampled for several parameters including selenium. The permit has no selenium limits. To date, all selenium levels in the discharge have been below 5 µg/L. Observed selenium levels in Burnett Creek have usually been below detection limits. On September 2020 a selenium concentration was 30 µg/L was

observed downstream from the discharge, still well below the chronic selenium standard. No other instream concentrations were above 5 µg/L. Therefore, the discharge is considered not to be a significant contributor of selenium or selenium compounds. The NPDES discharge permit is being modified to include stormwater runoff and potentially contaminated groundwater from the pond, and monitoring will continue to include selenium.

Combined sewer systems convey a mixture of raw sewage and storm water in the same conveyance structure to a wastewater treatment plant. When the combined sewage exceeds the capacity of the wastewater treatment plant, the excess is diverted to a combined sewage overflow (CSO) discharge point. There are no CSO outfalls located within the impaired stream segment watersheds.

3.1.2 Regulated Storm Water Discharges

Certain sources of stormwater runoff are covered under the NPDES Permit Program. It is considered a diffuse source of pollution. Unlike other NPDES permits that establish end-of-pipe pollutant limits, storm water NPDES permits establish controls intended to reduce the quantity of pollutants that storm water picks up and carries into storm sewer systems during rainfall events. Currently, regulated storm water discharges include those associated with industrial activities, construction sites one acre or greater, large and medium municipal separate storm sewer systems (MS4s), and small MS4s serving urbanized areas.

3.1.2.1 Industrial General Storm Water NPDES Permit

Storm water discharges associated with industrial activities are currently covered under Georgia's General Industrial Storm Water NPDES Permit (GAR050000). This permit requires visual monitoring of storm water discharges, site inspections, implementation of Best Management Practices (BMPs), preparation of a Storm Water Pollution Prevention Plan (SWPPP), and annual reporting. The Industrial General Permit requires that storm water discharging into an impaired stream segment or within one linear mile upstream of, and within the same watershed as, any portion of an impaired stream segment identified as "not supporting" its designated use(s), must satisfy the requirements of Appendix C of the permit if the pollutant(s) of concern for which the impaired stream segment has been listed may be exposed to storm water as a result of industrial activity at the site. If a facility is covered under Appendix C of the Industrial General Permit, then benchmark monitoring for the pollutant(s) of concern is required. There are 6 facilities in the Gibson Creek watershed, no facilities in the Purvis Creek watershed, and 21 facilities in the Brunswick River tidal watershed covered under the Industrial General Permit. Based on their SIC Codes, Sector designations, and required benchmark sampling, none of these facilities are sources for selenium or selenium compounds.

3.1.2.2 MS4 NPDES Permits

The collection, conveyance, and discharge of diffuse storm water to local water bodies by a public entity are regulated in Georgia by the NPDES MS4 permits. These MS4 permits have been issued under two phases. Phase I MS4 permits cover medium and large cities, and counties with populations over 100,000. Each individual Phase I MS4 permit requires the prohibition of non-storm water discharges (i.e., illicit discharges) into the storm sewer systems and controls to reduce the discharge of pollutants to the maximum extent practicable, including the use of management practices, control techniques and systems, as well as design and engineering methods (Federal Register, 1990). A site-specific Storm Water Management Plan (SWMP) outlining appropriate controls is required by and referenced in the permit. A program to monitor and control pollutants in storm water discharges from industrial facilities, construction

sites, and highly visible pollutant sources that exist within the MS4 area must be implemented under the permit. Additionally, monitoring of not supporting streams, public education and involvement, post-construction storm water controls, low impact development, and annual reporting requirements must all be addressed by the permittee on an ongoing basis.

Small MS4s serving urbanized areas are required to obtain a storm water permit under the Phase II storm water regulations. An urbanized area is defined as an area with a residential population of at least 50,000 people and an overall population density of at least 1,000 people per square mile. Thirty counties, fifty-six communities, seven Department of Defense facilities, and the Georgia Department of Transportation (GDOT) are permitted under the Phase II regulations in Georgia. All municipal Phase II permitees are authorized to discharge under Storm Water General Permit GAG610000. Department of Defense facilities are authorized to discharge under Storm Water General Permit GAG480000. GDOT owned or operated facilities are authorized to discharge under Storm Water General Permit GAG410000. Under these general permits, each permittee must design and implement a SWMP that incorporates BMPs that focus on public education and involvement, illicit discharge detection and elimination, construction site runoff control, post-construction storm water management, and pollution prevention in municipal operations. The MS4 permittees that discharge to Gibson Creek, Purvis Creek, and the Brunswick River are shown in Table 4.

Table 4. Permitted MS4s in the Satilla River Basin

Stream Segment	MS4 Permittees	MS4 Phase
Brunswick River	City of Brunswick	2
	Glynn County	2
Gibson Creek	Glynn County	2
Purvis Creek	Glynn County	2

Source: EPD Watershed Protection Branch, Nonpoint Source Program, 2015

Table 5 provides the total drainage areas of the not supporting segments of the Brunswick River, Gibson Creek, and Purvis Creek, and the percentage of urbanized areas in the permitted MS4 areas contained within the watersheds. The land use types that are considered urbanized include 1) developed open space, 2) developed low intensity, 3) developed medium intensity, 4) developed high intensity, 5) utility swaths, and 6) golf courses.

Table 5. Percentage of Watersheds Located in MS4 Areas or Urban Areas

Stream Segment	Total Area (sq. mi.)	% In MS4 Urbanized Area
Brunswick River	278.0	5.3
Gibson Creek	14.5	30.3
Purvis Creek	1.3	12.4

MS4 permittees are required to have an Impaired Waters Plan (IWP) if a stream on the 303(d) list occurs within their jurisdiction or within one mile of their permitted stormwater outfalls. The

IWP requires monitoring of the outfall receiving stream for the parameter causing the impairment. The City of Brunswick and Glynn County have MS4 stormwater outfalls that are located within one mile of the Brunswick River. Glynn County has MS4-permitted outfalls that are located within one mile of Gibson Creek and Purvis Creek. Both the City and the County have MS4 IWPs. Selenium was recently added to their IWPs as a parameter to be monitored. Data is currently not available to determine the significance of urban runoff from the City and County as a source of selenium.

3.2 Nonpoint Source Assessment

In general, nonpoint sources cannot be identified as entering a water body through a discrete conveyance at a single location. In urban areas, a large portion of the storm water contribution may enter waterways as point sources from MS4 NPDES permitted outfalls, or from industrial sites covered under the Georgia Industrial General Permit. The remainder of the storm water runoff will come from nonpoint sources.

Potential nonpoint sources include the following:

- Storm water runoff as overland flow from improper disposal of waste materials;
- Deposition of particulates from air emissions;
- Contaminated groundwater seepage;
- Leaking or overflowing sanitary sewer lines;
- Failing septic systems;
- Leachate from landfills within the watershed;
- Storm water runoff from private outfalls not covered under NPDES MS4 permits;
- Storm water runoff from industrial sites not currently included under the Georgia General Industrial Permit;
- Natural geological and environmental processes

An assessment of the potential sources of selenium in impaired stream segments was performed using available resources, which included the following databases:

- USEPA Toxics Release Inventory (TRI)
- USEPA List of Superfund Sites (SEMS)
- USEPA Brownfields Program
- EPD Brownfields Public Record
- EPD Hazardous Site Inventory (HSI)
- EPD Inventory of Permitted Solid Waste Disposal Facilities

3.2.1 Toxic Release Inventory (TRI)

The TRI is a database maintained by the USEPA that provides information about facilities that handle toxic chemicals. Facilities in certain industry sectors that manufacture, process, or otherwise use these chemicals in amounts above established levels, must report how each chemical is managed. The TRI contains information about releases of these chemicals to the environment, including air emissions, surface water discharges, releases to the land, and off-site transport to recycling or disposal facilities.

There are no facilities included on the TRI that have reported releases of selenium or selenium compounds above established reportable levels within the Gibson Creek, Purvis Creek, or Brunswick River tidal drainage areas.

3.2.2 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Sites

The Comprehensive Environmental Response, Compensation, and Liability Act, otherwise known as CERCLA or Superfund, along with the Superfund Amendments and Reauthorization Act (SARA) of 1986, provides a Federal "Superfund" to clean up uncontrolled or abandoned hazardous-waste sites, as well as accidents, spills, and other emergency releases of pollutants and contaminants into the environment. EPA maintains SEMS (formerly CERCLIS), which is a list of Superfund sites for all States in the U.S. No sites are included on the SEMS that are located within the Gibson Creek drainage area, one site on the National Priority List (NPL) is located within the Purvis Creek watershed, and nine sites are located within the Brunswick River tidal watershed; four of which are on the NPL. However, none of the Superfund sites located within these watersheds have had reported releases of selenium or selenium compounds.

3.2.3 Hazardous Site Index (HSI)

The HSI is maintained by EPD. Industrial sites are placed on this list by EPD when there has been a known release into the environment of a regulated substance above a reportable quantity that may pose a risk to human health and the environment. There are three sites on the HSI located within the Gibson Creek watershed and one site in the Purvis Creek watershed. None of these sites have reported releases or the presence of selenium or selenium compounds. There are 16 sites on the HSI within the Brunswick River tidal watershed. Two of these sites, Atlanta Gas Light site and the Georgia-Pacific T-Street Dump, are known to have releases or have had selenium or selenium compounds present above reportable quantities as determined by EPD (Table 6). Selenium is not the primary target parameter for the Atlanta Gas Light site or the Georgia-Pacific T-Street Dump site. However, selenium was on the list of reported regulated substances present based on chemical analyses performed for the site assessments and corrective actions being conducted at these sites are for parameters other than selenium.

Cleanup actions have been completed for the Atlanta Gas Light site. The Atlanta Gas Light site was removed from the HSI list in May 2017.

Table 6. Industrial Sites on the Hazardous Site Index (HSI) for Releases of Selenium within the Impaired Stream Segments Watersheds in the Satilla River Basin

Site Name	Watershed	HSI Number	Class (1)	Medium of Contamination	Facility Status	Status of Cleanup Activities
Atlanta Gas Light Co.	Brunswick River	10069	V	groundwater	closed	completed
Georgia-Pacific Corp., T-Street Dump	Brunswick River	10317	V	groundwater, soil	closed	ongoing

EPD Land Protection Branch, Hazardous Waste Management Program, 2020
(1) Class: V Site is known to have had a release that requires corrective action, and corrective action is currently being performed. However, the corrective action measures are for parameters other than selenium.

3.2.4 Brownfields

A brownfield is a property on which activities, often by former owners or tenants, have resulted in the presence or potential presence of a hazardous substance, pollutant, or contaminant. EPA maintains a list of known brownfields that have been identified as potential candidates for

cleanup activities through its Brownfields Program, and for sites where cleanup operations are underway or have been completed. Georgia has developed a public record of Brownfields located within the State through funding provided by the EPA. The Brownfield public record is maintained by EPD's Land Protection Branch Brownfield Development Unit.

There are seven Brownfield sites are located within the Brunswick River tidal drainage area. Selenium was found to be present at three of these sites. However, selenium was not reported to be a constituent of concern at any of these sites. There are no Brownfield sites within the Gibson Creek or Purvis Creek watersheds.

3.2.5 Solid Waste Disposal Facilities

Leachate from landfills may contain dissolved selenium or selenium compounds that could at some point reach surface waters. Sanitary landfills receive household wastes that may include household and yard chemicals and relatively small amounts of construction and demolition wastes generated from private homeowner activities. The large portion of waste generated from construction and demolition activities are sent to landfills designated for these materials. Designated construction/demolition landfills receive the vast majority of wastes from these activities. Older sanitary landfills were not lined and most have been closed. Those landfills that are not lined and remain active, operate as construction/demolition landfills. Currently, active sanitary landfills are lined and have leachate collection systems. All landfills, excluding inert landfills, are now required to install environmental monitoring systems for groundwater and methane sampling. Selenium is included as a parameter in the groundwater monitoring. There are sixteen known landfills located within the watersheds of the impaired stream segments (Table 7). Two closed landfills are in the Gibson Creek watershed, and one inactive landfill is in the Purvis Creek watershed. All sixteen landfills are located within the Brunswick River tidal watershed. Two of these landfills are operating, eight are inactive, and six are closed. For those landfills with ongoing groundwater monitoring, selenium has not been shown to be a constituent of concern.

Table 7. Landfills Upstream of 303(d) Listed Segments in the Satilla River Basin

Name	County	Landfill Type	Permit No.	Status
Brunswick River				
Brunswick Pulp & Paper Co.	Glynn	NA	063-002D(L)	Inactive
City of Brunswick - Dolphin Street	Glynn	Dry Trash Landfill	063-018D(L)	Closed
Eller - Whitlock Ave.	Glynn	Construction and Demolition	063-025D(L)	Operating
Georgia Pacific Brunswick Operations	Glynn	Industrial Landfill	063-002D(LI)	Operating
Glynn County - Cate Road L	Glynn	Construction and Demolition	063-024D(L)	Closed
Glynn County - Cate Road SL	Glynn	Sanitary Landfill	063-015D(SL)	Closed
Glynn County - Frederica Academy SSI	Glynn	Dry Trash Landfill	063-016D(L)	Closed
Glynn County - Hwy. 99	Glynn	Dry Trash Landfill	063-010D(L)	Inactive
Glynn County - Lawrence Road	Glynn	Unknown	-	Inactive
Glynn County - Lawrence Road	Glynn	Dry Trash Landfill	063-009D(L)	Inactive

Name	County	Landfill Type	Permit No.	Status
Hutcheson - Petersville Road	Glynn	Dry Trash Landfill	063-019D(L)	Closed
Merrit - SR 303/US 341	Glynn	Dry Trash Landfill	063-022D(L)	Closed
Sterling	Glynn	Unknown	-	Inactive
T Street	Glynn	Unknown	-	Inactive
Thalmann	Glynn	Unknown	-	Inactive
Waynesville	Brantley	Unknown	-	Inactive
Gibson Creek				
Hutcheson - Petersville Road	Glynn	Dry Trash Landfill	063-019D(L)	Closed
Merrit - SR 303/US 341	Glynn	Dry Trash Landfill	063-022D(L)	Closed
Purvis Creek				
Brunswick Pulp & Paper Co.	Glynn	NA	063-002D(L)	Inactive

Source: EPD, Land Protection Branch, Solid Waste Management Program, 2019

3.3 Additional Potential Sources

A review of scientific literature revealed that the most common sources of elevated levels of selenium in surface waters are agriculture irrigation using ground water where selenium has been leached from soils and aquifers composed of marine deposits and marine shales (EPA, 2016; Luoma and Presser, 2009; Reeder and Schneider, 2009; Utah Dept. of Environmental Quality, 2013), mining and smelting of ores containing sulfide minerals; atmospheric deposition and discharge from fly-ash ponds associated with coal-fired power plants (EPA, 2016; Lemly, 2000; Salimen, 2005; Santiago, et. al., 2014), urban stormwater runoff (EPA, 2016; Larry Walker Associates, 2006; Tetra Tech, 2008), and selenium leached from marine sediments and shales in coastal areas (Luoma and Presser, 2009; Reeder and Schneider, 2009). Some scientific publications have suggested that discharges from municipal and industrial wastewater treatment plants are sources of selenium (Salimen, 2005; Larry Walker Associates, 2006), although usually of secondary importance in regions where elevated levels of selenium are observed.

3.3.1 Agriculture Irrigation

Along coastal Georgia ground water is used primarily for city drinking water supplies, industrial activities, irrigation of golf courses, and water supplies for residences using private wells. Agriculture in southeast Georgia, and specifically near the Brunswick River watershed, consists primarily of blueberry farming and other crops where irrigation is not widely used. Ground water in this region of Georgia is drawn from the Brunswick Aquifer and the deeper Floridan Aquifer (EPD, 2017). Using EPD's GOMAS database, an examination of water quality data collected from 27 wells located within 50 miles of Georgia's coastline showed only one well having a detectable level of selenium at 10 µg/L. The remaining wells showed selenium levels below detectable limits. The various uses of ground water in the Brunswick River Watershed area, and more generally along the entire coastline of Georgia, are not considered a significant source of selenium.

3.3.2 Mining and Smelting Operations

There are no major mining operations located within the Brunswick River watershed or adjacent watersheds. Burrow pit and small quarry operations are scattered throughout the area (EPD, 2020). These are primarily used as sources for fill material, topsoil, and sand used for construction and landscaping activities. Although the unearthing and excavation of buried marine deposits could result in exposing these materials to erosion and leaching processes, this is likely only a minor source of selenium into nearby waterways. Based on available water quality data from streams located downstream from these excavations sites, selenium concentrations are usually below detection limits. Mining and quarry operations are not considered a significant source of selenium to waterways in the Brunswick Watershed area.

3.3.3 Coal-fired Power Plants

Power plants fueled by coal have been shown to release selenium into the environment primarily through fugitive air emissions resulting from the burning of coal, and from controlled releases of storm water from fly-ash ponds (EPA, 2016; Salimen, 2005; Santiago, et. al., 2014). The former Plant McManus power plant, owned by Georgia Power, is located near the confluence of Burnett Creek and the Turtle River, immediately northwest of the City of Brunswick. The facility was originally built in the 1950's as a coal-fired plant. It was converted to an oil-fired facility in the 1970's. The Plant McManus facility was shut down and decommissioned in April 2015. In May 2016, the main plant and stacks were purposely demolished by implosion.

Georgia Power is currently implementing an ash-pond dewatering plan with a permitted discharge to Burnett Creek, a tributary of the Turtle River. The discharge is monitored for several parameters including selenium. To date, selenium levels in the discharge have remained low, at less than 5 µg/L. The former power plant is not considered a significant source of selenium to the Brunswick River system. There are no other power plants located in the vicinity of the Brunswick River watershed.

3.3.4 Marine Sediments

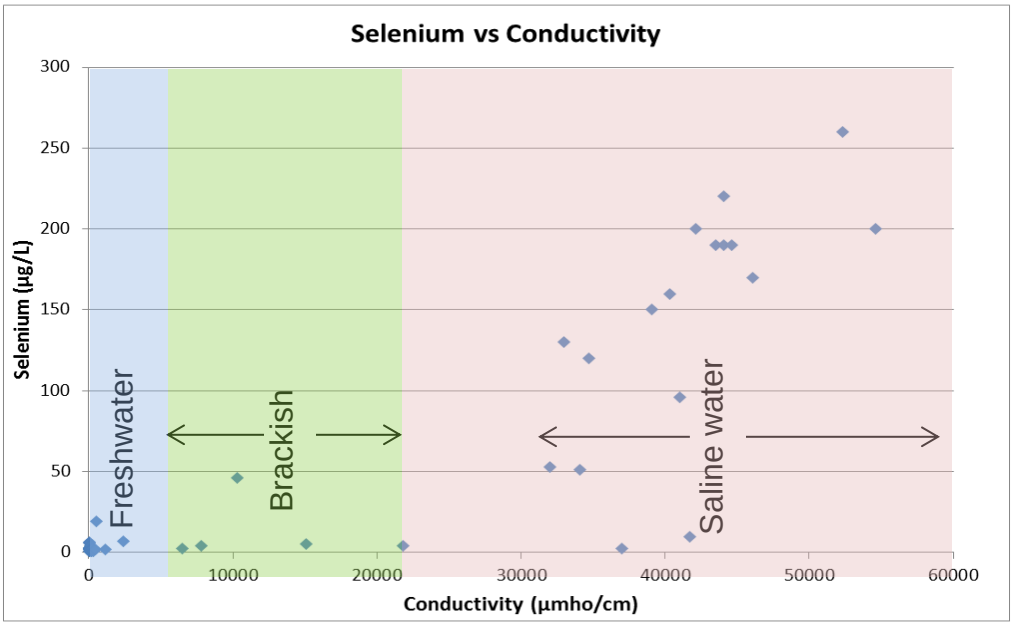
The various potential sources for selenium that might originate from upstream watersheds for the Brunswick River, Gibson Creek, and Purvis Creek have been investigated. No sources upstream were found that could contribute selenium at the levels observed in these waterbodies. Therefore, attention was directed to the estuarine environment and coastal waters as potential sources.

The Brunswick River system, of which Gibson Creek and Purvis Creek are part of, is essentially an estuary with associated tidal marshes that receive upstream drainage from a portion of the Satilla River Basin. The largest volume of water that courses through this system is provided by the coastal tides. The water temperatures are generally warm through most of the year due to the southern location of the Georgia coast. Average temperatures remain above 72 degrees during the months of May through October (NOAA, 2017). As such, it is a biologically productive water body with a long growing season supporting all trophic levels. Selenium is an essential element for most organisms at low levels. It enters the food chain at the microbe level and bioaccumulates up through the food chain. The greatest rate of bioaccumulation appears to take place at the phytoplankton, plankton, and shellfish trophic levels, with fish being the end consumers at the top of the food chain (Louma and Pressor, 2009; Baginska, 2015). These organisms die and become part of the estuary and tidal marsh sediments. As their bodies degrade, selenium may slowly be released back into the water column. The oxygen levels and

slightly alkaline pH levels observed in the Brunswick River would augment the release of selenium in dissolved form (Reeder and Schneider, 2009; EPA, 2016; Luoma and Presser, 2009; Salimen, et. al.). These processes may potentially be a significant source of selenium found in the Brunswick River and Gibson and Purvis Creeks.

A survey of water quality data for streams near the coast, upstream from the tidal zone, show selenium levels to be non-detect or to have low concentrations less than 50 µg/L. Surficial marine deposits would not be expected to be present in these streams upstream from the tidal zone. However, in the tidal zone where saltwater conditions predominate (i.e., indicated by high conductivity levels) and marine deposits would be present, stream selenium concentrations were usually greater. Figure 5 is a plot of all stream samples collected in the State of Georgia that included the parameters selenium and conductivity. For graphing purposes, selenium concentrations below detection limits were assigned a value of half the detection limit. As shown in Figure 5, the samples with low conductivities representative of freshwater (i.e., less than approximately 1,200 µmho/cm) typically had selenium levels ranging from non-detect to less than 50 µg/L. In low to medium brackish waters (i.e., conductivities ranging from 2,100 to slightly over 20,000 µmho/cm), typical for waters near the edge of the tidal zone, selenium levels were also generally low. However, in samples collected within estuaries along the coast dominated by saline conditions (i.e., conductivities greater than 30,000 µmho/cm), the selenium levels were usually significantly higher, ranging from concentrations greater than 50 µg/L up to 260 µg/L. This suggests that higher selenium levels are associated with estuarine waters, such as the Brunswick River, Gibson Creek, and Purvis Creeks.

Figure 5. Comparison of Selenium to Conductivity for Freshwater, Brackish Water and Saltwater Environments



The available water quality data for the Brunswick River watershed and other areas along the Georgia coast suggests the possibility marine deposits may be a source of selenium. There essentially has been no sediment sampling for selenium analysis from the coastal areas or tidal marshes in this region to confirm this. There also are no selenium data available for samples collected from this region of the Atlantic Ocean beyond the barrier islands to indicate how much, if any, selenium may be brought into these estuarine environments from sources beyond the barrier islands.

The assessment of current conditions indicates that known anthropogenic sources are likely contributing only low levels of selenium to the Brunswick River system. However, the selenium from these sources may over time increase in concentration through the combined processes of bioaccumulation, deposition, and leaching from the organic deposits in the sediments. This should be further investigated. There may also have been historical activities within the Brunswick River watershed that introduced selenium to the impaired streams for which no records could be found.

3.4 Source Assessment Summary

An important part of the TMDL analysis is the identification of potential sources of pollutants. Under the CWA requirement to develop TMDLs for waters on the 303(d) list not supporting their designated uses, point source and nonpoint source inputs are considered when developing water-quality based controls to reduce pollution and restore and maintain water quality. Sections 3.1 through 3.3 describe point and nonpoint assessments.

Within the point source assessment findings, 12 NPDES-permitted municipal or industrial wastewater treatment facilities discharge to the Brunswick River tidal watershed, 2 industrial facilities discharge to Gibson Creek, and no permitted discharges exist within the Purvis Creek drainage. The effluent from the Plant McManus fly-ash pond is the only permitted discharge monitoring for selenium. The maximum selenium concentration observed from this discharge has been 3.3 µg/L, with the majority of samples showing selenium to be below detection limits. There are 21 facilities in the Brunswick River tidal watershed and 6 facilities in the Gibson Creek watershed that are covered under the NPDES Industrial General Stormwater Permit. Based on their SIC code, sector designation, and required benchmark monitoring, none of these facilities have the potential to discharge selenium. One MS4 permittee, Glynn County, discharges into Gibson Creek and Purvis Creek. Two MS4 permittees, Glynn County and the City of Brunswick, discharge into the Brunswick River. Each of the impaired segments contains areas defined as urbanized within their watersheds. Data is currently not available to determine the significance of urban runoff from the City and County as a source of selenium.

Nonpoint source assessment findings include possible sources documented in the Toxic Release Inventory (TRI), those identified as CERCLA sites, sites on the Hazardous Site Index (HSI), brownfields, solid waste disposal facilities, and other sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. Within the impaired stream segments watersheds:

- There are no TRI sites that have reported releases of selenium or selenium compounds above established reportable levels

- There are no CERCLA sites known to have uncontrolled selenium or selenium compounds present or to have had releases of these compounds into the environment.

- There are two HSI sites that were listed as having selenium present. However, the selenium concentrations at these sites were low and not considered significant.

- There are three brownfield sites within the Brunswick River drainage area where selenium was found to be present. The selenium occurred at low levels and was not considered to be a constituent of concern.

- There are 16 landfills located within the Brunswick River tidal watershed. Two of these

landfills are active, eight are inactive, and six are closed. Two closed landfills are in the Gibson Creek watershed, and one inactive landfill is in the Purvis Creek watershed. For those landfills requiring ongoing groundwater monitoring, selenium has not been found to be a constituent of concern.

- The marine sediments underlying the Brunswick River and St. Simons Sound may be a potential source of selenium. These sediments are composed, in part, of the remains of marine organisms which have bioaccumulated selenium, and upon decomposition, may slowly release selenium into the estuarine waters of the Brunswick River and Gibson and Purvis Creeks.

4.0 TMDL DEVELOPMENT APPROACH

The process of developing selenium TMDLs for the Satilla River Basin listed segments includes the determination of the following:

- The current critical selenium load to the impaired water bodies under existing conditions;
- The TMDL for similar conditions under which the current load was determined; and
- The percent reduction in the current critical selenium load necessary to achieve the TMDL.

The calculation of the selenium load in a coastal stream segment requires the selenium concentration and an estimate of the flow volume. A mass balance approach was used to determine the current selenium load and TMDL. For the listed segments, selenium sampling data were compared to the regulatory criteria.

4.1 Mass Balance Approach

For those segments in which sufficient water quality data were collected to list them as impaired, a mass balance approach was used. This method involves comparing the current critical load to the applicable selenium water quality criteria. Under conditions where the impaired stream segment is not subject to tidal conditions and flow is primarily a function of the base flow and drainage from the upstream watershed, total daily mass loads for the low flow conditions of 1Q10 and 7Q10 are given. It is assumed that these are the critical conditions for aquatic life. The 1Q10 and the acute criteria provide protection of the acute standard, and the 7Q10 and chronic criteria provide protection of the chronic standard.

The listed segment of the Brunswick River is estuarine in nature, and it's flow regime is dictated by the coastal tides. Both Gibson Creek and Purvis Creek, also tidal streams, connect with the Turtle River, which is essentially an upstream extension of the Brunswick River. The flow in these streams is directly connected to the flow in the Turtle River-Brunswick River system, and their water quality is similar to that found in the River. Therefore, the flow in the Brunswick River and Gibson and Purvis Creeks continually varies as the tide is coming in and going out. Thus, the concepts of 1Q10 and 7Q10 do not apply. As a result, the current critical loads and the TMDLs are expressed as equations that show the loads as a function of the total flow at any given time. The general equations for the critical load and the TMDL are:

$$L_{critical} = C \times Q_{est}$$

Where:

$L_{critical}$ = current critical selenium load
C = selenium concentration
Q_{est} = estimated instantaneous flow

and:

$$TMDL = C \times Q_{est}$$

Where:

TMDL = total maximum daily selenium load
C = selenium criterion
Q_{est} = estimated instantaneous flow

Since instantaneous samples are used to evaluate compliance with the standards, as well as the need for a TMDL, this flow dependent load, or concentration approach makes it easier to evaluate compliance with the TMDL.

The difference between the current critical load and the TMDL represents the load reduction required for the impaired segment to meet the appropriate instream selenium standard. If a single sample exceeds the selenium criterion, then the TMDL is based on the criteria exceedance requiring the largest load reduction. The percent load reduction can be expressed as follows:

$$\text{Percent Load Reduction} = \frac{L_{critical} - TMDL_{critical}}{L_{critical}} \times 100$$

For the impaired stream segments in the Satilla River Basin, there were no exceedances of the acute selenium criterion. Therefore, the critical loads were evaluated against the chronic criterion.

The saltwater acute and chronic criteria for selenium are expressed as the dissolved fraction. Results for sample analyses of selenium are commonly reported as a total (or total recoverable) concentration. Because the criteria are for the dissolved fraction of the selenium, Georgia Regulation 391-3-6-.03(5)(e)(ii) (EPD, 2021) allows USEPA's "The Metals Translator: Guidance For Calculating A Total Recoverable Permit Limit From A Dissolved Criterion, June 1996" (USEPA, 1996) to be used for "translating" the total recoverable concentration to the dissolved form. In addition, Georgia Regulation 391-3-6-.06(4)(d)5.(ii)(b)(2) allows methods from this EPA guidance document to be used to translate dissolved criteria concentrations into total recoverable permit limits. Selenium effluent permit limitations are required to be expressed as total recoverable metal per 40 CFR §122.45(c). The saltwater conversion factor to convert total recoverable selenium to dissolved selenium is 0.998.

5.0 ALLOCATIONS

A TMDL is the amount of a pollutant that can be assimilated by the receiving water body without exceeding the applicable water quality standard. The TMDLs for selenium are based on the acute and chronic instream standards. A TMDL is the sum of the individual wasteload allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources, as well as natural background (40 CFR 130.2) for a given water body. The TMDL must also include a margin of safety (MOS), either implicitly or explicitly, which accounts for the uncertainty in the relationship between pollutant loads and the water quality response of the receiving water body. TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measures. For selenium the TMDLs are expressed as mass per day and as a concentration. A TMDL is expressed as:

$$TMDL = \Sigma WLAs + \Sigma LAs + MOS$$

The TMDL calculates the WLAs and LAs with margins of safety to meet the stream's water quality standards. The allocations are based on estimates that use the best available data and provide the basis to establish or modify existing controls so that water quality standards can be achieved. In developing a TMDL, it is important to consider whether adequate data exists to identify the sources, fate, and transport of the pollutant to be controlled.

TMDLs may be developed using a phased approach. Under a phased approach, the TMDL includes: 1) WLAs that confirm existing limits and controls or result in new limits, and 2) LAs that confirm existing controls or include implementing new controls (USEPA, 1991). A phased TMDL requires that additional data be collected to determine if reductions required by the TMDL are leading to the attainment of water quality standards.

The TMDL Implementation Plan establishes a schedule or timetable for the installation and evaluation of point and nonpoint source control measures, data collection, assessment of water quality standard attainment, and if needed, additional modeling. Future monitoring of the listed segment's water quality will be used to evaluate this phase of the TMDL, and if necessary, to reallocate the loads.

5.1 Wasteload Allocations

5.1.1 Wastewater Treatment Facilities

The WLA is the portion of the receiving water's loading capacity that is allocated to existing or future point sources represented by municipal and industrial wastewater treatment systems that have NPDES effluent limits. Currently, there are no NPDES-permitted wastewater treatment facilities with selenium limits that discharge selenium into the impaired streams. In the future, if any wastewater treatment facilities are permitted to discharge to the impaired stream segments in the Satilla River Basin, the WLA loads will be calculated using the effluent design flow. Since some NPDES permits do not have a flow limitation, a TMDL expressed only in mass per day is not appropriate. It is more accurate and conservative to assign a WLA as a concentration. The mass limit for any value of flow (Q) will then be calculated by multiplying flow times concentration. The WLA requires that the effluent concentration from each point source not exceed the allowable instream selenium water quality criteria at the end of pipe without any dilution. The WLA is represented by the equation:

$WLA = \Sigma Q_{WLA} \times$ Selenium saltwater criterion (acute or chronic)

where: ΣQ_{WLA} = Sum of all current, potential, and future NPDES permitted wastewater treatment discharges

Se_{acute}= 290 µg/L
$Se_{chronic}$= 71 µg/L

5.1.2 Regulated Storm Water Discharges

State and Federal Rules define storm water discharges covered by NPDES permits as point sources. However, storm water discharges are from diffuse sources and there are multiple storm water outfalls. Storm water sources (point and nonpoint) are different than traditional NPDES permitted sources in four respects: 1) they do not produce a continuous (pollutant loading) discharge; 2) their pollutant loading depends on the intensity, duration, and frequency of rainfall events, over which the permittee has no control; 3) the activities contributing to the pollutant loading may include various allowable activities of others, and control of these activities is not solely within the discretion of the permittee; and 4) they do not have wastewater treatment plants that control specific pollutants to meet numerical limits.

The intent of storm water NPDES permits is not to treat the water after collection, but to reduce the exposure of storm water to pollutants by implementing various controls. It would be infeasible and prohibitively expensive to try to control pollutant discharges from each storm water outfall. Therefore, storm water NPDES permits require the establishment of controls or BMPs to reduce pollutants from entering the environment.

The wasteload allocations from storm water discharges (WLAsw) associated with municipal separate storm sewer systems (MS4s) are estimated based on the percentage of urban area in each watershed covered by the MS4 storm water permit. At this time, the portion of runoff from each watershed that goes directly to a permitted storm sewer or is non-permitted sheet flow or diffuse runoff has not been clearly defined. Thus, it is assumed that approximately 70 percent of storm water runoff from the regulated urban area is collected by the MS4. This can be represented by the following equation:

$WLA_{SW} = Q_{WLAsw} \times$ Selenium saltwater criterion (acute or chronic)

where: WLA_{SW} = Wasteload Allocation for permitted storm water runoff from all MS4 urban areas
Q_{WLAsw} = Runoff from all MS4 urban areas conveyed through permitted storm water structures
$Q_{WLAsw} = \Sigma Q_{urban} \times 0.7$
ΣQ_{urban} = Sum of all storm water runoff from MS4 urban areas

Se_{acute} = 290 µg/L (Selenium saltwater criterion, acute)
$Se_{chronic}$= 71 µg/L (Selenium saltwater criterion, chronic)

For stormwater permits, compliance with the terms and conditions of the permit is effective implementation of the WLA to the Maximum Extent Practicable (MEP), and demonstrates consistency with the assumptions and requirements of the TMDL. EPD acknowledges that progress with the assumptions and requirements of the TMDL by stormwater permittees may take one or more permit iterations. Achieving the TMDL reductions may constitute compliance with a stormwater management plan (SWMP) or a stormwater pollution prevention plan

(SWPPP), provided the MEP definition is met, even where the numeric percent reduction may not be achieved so long as reasonable progress is made toward attainment of water quality standards using an iterative BMP process.

5.2 Load Allocations

The load allocation (LA) is the portion of the receiving water's loading capacity that is attributed to existing or future nonpoint sources or to natural background sources. Nonpoint sources are identified in 40 CFR 130.6 as follows:

- Residual waste
- Land disposal
- Agricultural and silviculture
- Mines
- Construction
- Saltwater intrusion
- Urban storm water (non-permitted)

It is not known how much of the selenium contributions to the impaired stream segments are from nonpoint sources. Generally, there are two types of load allocations in the creek: 1) loads associated with the accumulation of selenium on land surfaces that are washed off during storm events, and; 2) loads independent of precipitation, such as seepage of contaminated groundwater, leachate from landfills, failing septic systems, leaking sewer system collection lines, and natural background loads. Available data suggests that selenium introduced to the impaired stream segments are from natural background sources, and to a lesser extent stormwater runoff and from other sources not related to storm events. At this time, it is not possible to partition the various sources of load allocations. In the future, after additional data has been collected, it may be possible to partition the load allocation by source.

The LA for all flows and conditions can be described by the following equation:

$LA = Q_{LA}$ x Selenium saltwater criterion (acute or chronic)

where: LA = Load Allocation
Q_{LA} = Flow from all nonpoint sources
$Q_{LA} = Q_{Total} – (\Sigma Q_{WLA} + \Sigma Q_{WLAsw})$
Q_{Total} = Total flow
ΣQ_{WLA} = Sum of all current, potential, and future NPDES permitted wastewater treatment discharges
ΣQ_{WLAsw} = Sum of runoff from all MS4 urban areas conveyed through permitted storm water structures

Se_{acute} = 290 µg/L (Selenium saltwater criterion, acute)
$Se_{chronic}$ = 71 µg/L (Selenium saltwater criterion, chronic)

5.3 Seasonal Variation

The growing season for coastal marine plankton is primarily during the summer months. If the selenium levels in Brunswick River, Gibson Creek, and Purvis Creek are, in part, due to the die-off and decay of plankton and shellfish, then there may be seasonal variation in the release of selenium to these water bodies. However, the current available data does not show seasonal variation of selenium concentrations for the impaired stream segments.

Another seasonal aspect may be related to the tides. The ocean tides are not only a result of the gravitational pull of the moon, but also the sun. This adds a seasonal component to the observed magnitude of the tides. Thus, the overall flow volumes for the impaired stream segments may vary over the seasons. Seasonal variability in flow is addressed by expressing the TMDL as a concentration, as well as a load associated with these different flows.

5.4 Margin of Safety

The MOS is a required component of TMDL development. As specified by section 303(d) of the CWA, the margin of safety must account for any lack of knowledge concerning the relationship between effluent limitations and water quality. There are two basic methods for incorporating the MOS: 1) implicitly incorporate the MOS using conservative model assumptions to develop allocations, or 2) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations.

For this TMDL, an explicit MOS of 10 percent of the TMDL was used. This results in a reduction in the LA equal to the MOS.

5.5 TMDL Results

The TMDL for any condition will be based on the tidal flow of the stream, and the sum of the flows of permitted discharges. The TMDLs for selenium are summarized in Table 9.

Table 9. Total Dissolved Selenium TMDL Summary for the Impaired Stream Segments in the Satilla River Basin

Stream Segment	Criteria	Current Load(1)	TMDL Components					Percent Reduction Required
			WLA(2)	WLA_{SW}	LA	MOS(1)	TMDL(1)	
Brunswick River (GAR030702030211)	Acute	Q_{Total} x 9.82 x 10^{-1} kg/day	--	Q_{WLAsw} x 9.88 x 10^{-1} kg/day	Q_{LA} x 9.88 x 10^{-1} kg/day	Q_{Total} x 1.10^{-1} kg/day	Q_{Total} x 1.10 kg/day	0.0%
	Chronic	Q_{Total} x 9.82 x 10^{-1} kg/day Q_{Total} x 259.5 µg/L	--	Q_{WLAsw} x 2.42 x 10^{-1} kg/day	Q_{LA} x 2.42 x 10^{-1} kg/day	Q_{Total} x 2.69 x 10^{-2} kg/day	Q_{Total} x 2.69 x 10^{-1} kg/day	72.6%
Gibson Creek (GAR030702030202)	Acute	Q_{Total} x 5.67 x 10^{-1} kg/day Q_{Total} x 149.7 µg/L	--	Q_{WLAsw} x 9.88 x 10^{-1} kg/day	Q_{LA} x 9.88 x 10^{-1} kg/day	Q_{Total} x 1.10^{-1} kg/day	Q_{Total} x 1.10 kg/day	0.0%
	Chronic	Q_{Total} x 5.67 x 10^{-1} kg/day Q_{Total} x 149.7 µg/L	--	Q_{WLAsw} x 2.42 x 10^{-1} kg/day	Q_{LA} x 2.42 x 10^{-1} kg/day	Q_{Total} x 2.69 x 10^{-2} kg/day	Q_{Total} x 2.69 x 10^{-1} kg/day	52.6%
Purvis Creek (GAR030702030203)	Acute	Q_{Total} x 4.53 x 10^{-1} kg/day Q_{Total} x 119.8 µg/L	--	Q_{WLAsw} x 9.88 x 10^{-1} kg/day	Q_{LA} x 9.88 x 10^{-1} kg/day	Q_{Total} x 1.10^{-1} kg/day	Q_{Total} x 1.10 kg/day	0.0%
	Chronic	Q_{Total} x 4.53 x 10^{-1} kg/day Q_{Total} x 119.8 µg/L	--	Q_{WLAsw} x 2.42 x 10^{-1} kg/day	Q_{LA} x 2.42 x 10^{-1} kg/day	Q_{Total} x 2.69 x 10^{-2} kg/day	Q_{Total} x 2.69 x 10^{-1} kg/day	40.7%

(1) $Q_{Total} = Q_{LA} + Q_{WLAsw}$ (MGD)
(2) No permitted wastewater treatment facilities with selenium limits in watershed

6.0 RECOMMENDATIONS

The TMDL process consists of an evaluation of the sub-watersheds for each 303(d) listed stream segment to identify, as best as possible, the sources of selenium causing the stream to exceed instream standards. The TMDL analysis was performed using the best available data to specify WLAs and LAs that will meet selenium water quality criteria to support the use classification specified for each listed segment.

This TMDL represents part of a long-term process to reduce loading of selenium to meet water quality standards in the Satilla River Basin. Implementation strategies will be reviewed and the TMDLs will be refined as necessary. The phased approach will support progress toward water quality standards attainment in the future. In accordance with USEPA TMDL guidance, these TMDLs may be revised based on the results of future monitoring and source characterization data efforts. The following recommendations emphasize further source identification and involve the collection of data to support the current allocations and subsequent source reductions.

6.1 Monitoring

Elevated selenium concentrations have been observed at several locations in tidal streams and along Georgia's coast. However, the number of monitoring sites and frequency of sampling for selenium in these areas is relatively sparse. The Brunswick River monitoring site at US Highway 17 has probably been sampled for selenium more frequently than most sites along the coast. EPD took samples at this site from 2010 through 2015. Limited sampling was conducted on Gibson Creek and Purvis Creek during 2014.

Following are recommendations for future monitoring:

1. Sampling should be continued on the three impaired stream segments at the same locations samples were previously collected. In addition, the number of monitoring sites should be expanded to include other tidal streams in the region. These sites should be located in the tidal zones and upstream from the tidal zones. Samples should be taken at high-standing tide and low-standing tide, and during both dry-weather and wet-weather events. Monitoring sites should also be established within St. Simons Sound, as rising tides feed into the Brunswick River system from the Sound. This additional sampling should provide a clearer picture as to what are typical selenium concentrations for these water bodies, how frequently the selenium water quality standards are exceeded, and may provide clues as to potential sources.

2. Water quality monitoring sites should be established out in the ocean further away from the coastline, on the ocean-side of St. Simons Island and Jekyll Island. These monitoring locations may provide insight as to whether elevated selenium levels are limited to the estuaries, or if this is a common characteristic of the marine environment as a whole in this region.

3. As mentioned in Section 1.5 (Background Information), selenium is an essential nutrient in trace amounts for most animals including humans, and it is assumed selenium would be present in their wastes. Consideration should be given to adding selenium as a monitored parameter to the discharge and land application permits for coastal private, municipal, and industrial (where applicable) sanitary wastewater treatment systems that are located within the Brunswick River watershed. MS4 permittees are required to have

an Impaired Waters Plan (IWP) if a stream on the 303(d) list occurs within their jurisdiction or within one mile of their permitted stormwater outfalls. The IWP requires monitoring of the outfall receiving stream for the parameter causing the impairment. Selenium is required to be monitored for the Glynn County and City of Brunswick IWPs. This will provide information as to the significance of contributions of selenium from urbanized areas.

4. Selenium occurs naturally in sedimentary rock, shales, soils, and sediments. No sediment data for selenium could be found for the Brunswick River or for Gibson and Purvis Creeks. Sediment samples should be collected and analyzed for selenium in these streams, and should include sediments from within the tidal zones, and upstream from the tidal zones. The sediments of St. Simons Sound should also be sampled since waters from the Sound feed into the Brunswick River system during rising tide. This sampling may indicate whether the sediments might be a source for the elevated selenium levels observed in the Brunswick River, Gibson Creek and Purvis Creek.

5. Studies have shown that some marine organisms exhibit bioaccumulation of selenium in body tissues. This has been observed for certain inhabitants of estuarine environments, including plankton, shellfish, and fish. As these organisms die they settle to the bottom which may result in a concentration of selenium in the sediments. The slow release of selenium from these sediments could serve as a continual source for the estuarine waters. Consideration should be given to collecting organisms representing the different trophic levels in St. Simons Sound and the Brunswick River and analyzing the tissues for selenium. Examining the presence of selenium at the different trophic levels may prove informative as to the significance of bioaccumulation in the overall presence of selenium in these water bodies.

6.2 Management Practices

The implementation of management practices may reduce the amount of selenium released into water bodies. The following management practices are recommended to reduce selenium source loads to the impaired stream segments with the desired result of achieving the instream standard criteria for selenium:

- Compliance with future NPDES treated wastewater permit requirements;
- Compliance with NPDES MS4 permit requirements, where applicable;
- Compliance with NPDES Industrial General Permit requirements, including where applicable, achieving benchmark levels for monitored constituents;
- Ensure storm water management plans are in place and being implemented by the local governments, and by the industrial facilities located in the watershed;
- Implement Erosion and Sedimentation Control Plans for land disturbing activities; and application of the *Manual for Erosion and Sediment Control in Georgia* (GSWCC, 2016);
- Continue working with Federal, State, and local agencies and owners of sites where cleanup measures are necessary, and in developing control measures to prevent future releases of constituents of concern;

- Implementation of recommended Water Quality management practices in the *Suwannee Satilla Regional Water Plan* (2017);

- Application of Best Management Practices (BMPs) appropriate to both urban and rural land uses, where applicable.

6.2.1 Point Source Approaches

The NPDES permit program provides a basis for municipal, industrial, and stormwater permits, monitoring and compliance with permit limitations, and appropriate enforcement actions for violations. In accordance with EPD rules and regulations, all discharges from point source facilities are required to be in compliance with the conditions of their NPDES permit at all times. MS4 permittees are required to manage stormwater runoff through implementation of BMPs. Stormwater discharges from industrial sites are covered under the Stormwater Industrial General Permit must implement BMPs. Achieving the TMDL reductions may constitute compliance with a SWMP or SWPPP, provided the MEP definition is met, even where the numeric percent reduction may not be achieved so long as reasonable progress is made toward attainment of water quality standards using an iterative BMP process.

6.2.2 Nonpoint Source Approaches

EPD is the lead agency for implementing the State's Nonpoint Source Management Program, as described in Georgia's *Statewide Nonpoint Source Management Plan* (EPD, 2019). EPD will continue to work with local governments, agricultural, and forestry agencies such as the Natural Resources Conservation Service, the Georgia Soil and Water Conservation Commission, and the Georgia Forestry Commission to foster the implementation of BMPs that address nonpoint source pollution. The following sections describe programs in place and recommendations which should result in reducing nonpoint source loads of selenium and selenium compounds in Georgia's surface waters.

6.2.2.1 Waste Management

The Land Protection Branch (LPB) of EPD manages the disposal and treatment of solid waste through the permitting of municipal and industrial solid waste landfills, and oversees surface mining permitting and reclamation. The Industrial and Municipal Solid Waste Unit is responsible for the permitting, review of site suitability reports, construction, and closure of all publicly and privately owned solid waste handling facilities. It also reviews spill investigations and corrective action plans. Owners and/or operators of municipal solid waste landfills must conduct groundwater monitoring and evaluate the data to determine if established standards have been exceeded. All exceedances must be reported to EPD. The monitoring reports must be accompanied by a statement certifying that constituents which have established standards have been complied with or are non-compliant. It is recommended that monitoring of the groundwater continue to include periodic analysis for the presence of selenium.

Under RCRA, commercial and industrial facilities located within the watersheds of the impaired stream segments of the Satilla River Basin that handle selenium compounds must be monitored and provide information regarding the generation, transportation, treatment, storage, and disposal of hazardous waste. Government and businesses that generate or store hazardous waste are regulated through the LPB's Hazardous Waste Management Program. This Program investigates spills and releases involving hazardous waste and

determines the impact to soil and water. The LPB Response and Remediation Program works with the owners towards cleanup of the sites, and implementation of BMPs to minimize these releases.

6.2.2.2 Urban Sources

Runoff from urban areas has been noted in scientific literature as a source of selenium, although information regarding specific sources within urban environments is limited. Urban runoff as a potential source can best be addressed using a strategy that involves public participation and intergovernmental coordination to reduce the discharge of selenium to the maximum extent practicable. Management practices, control techniques, public education, and other appropriate methods and provisions may be employed. The following activities and programs conducted by cities, counties, and state agencies are recommended:

- Implement stormwater BMPs that incorporate water quality treatment and/or pollutant removal;
- Uphold requirements that all new and replacement sanitary sewage systems be designed to minimize discharges into storm sewer systems;
- Further develop and streamline mechanisms for reporting and correcting illicit connections, breaks, surcharges, and general sanitary sewer system problems;
- Continue efforts to increase public awareness and education regarding the impact of human activities on water quality, ranging from industrial and municipal discharges to individual's activities in residential neighborhoods.

6.3 Reasonable Assurance

Currently, there is one NPDES permitted wastewater treatment facility that is required to monitor selenium discharging in the Brunswick River watershed. There are no facilities that have permit limits that include selenium discharging in any of the impaired segments watersheds. Should there, in the future, be applicants for discharge permits, EPD will determine whether the applicants have a reasonable potential of discharging selenium levels equal to or greater than the allocated loads. The results of this reasonable potential analysis will determine the specific type of requirements in an individual facility's NPDES permit. As part of its analysis, EPD will use its EPA approved 2003 NPDES Reasonable Potential Procedures to determine whether monitoring requirements or effluent limitations are necessary. If effluent limitations are determined to be necessary, they should be established in accordance with *Georgia Rules and Regulations for Water Quality Control*, Section 391-3-6-.06(4)(d)5.(ii)(b)(2) (EPD, 2021), to protect against chronic and acute effects.

All industrial sites that have a storm water discharge associated with their primary industrial activity are required to submit a Notice of Intent under the NPDES General Industrial Permit that authorizes them to discharge storm water in accordance with the conditions and monitoring requirements established in the Industrial General Permit. Storm water from industrial sites that discharge within one linear mile of a 303(d) listed stream that might potentially contain the listed constituent must be monitored to determine that benchmarks levels are met.

The Brunswick River, Gibson Creek, and Purvis Creek watershed are covered under NPDES MS4 Permits. These permits prohibit illicit discharges into storm sewer systems, and require that BMPs be put in place to reduce the discharge of pollutants to the maximum extent possible.

6.4 Public Participation

A thirty day public notice is being provided for this TMDL. During this time, the availability of the TMDL will be public noticed, a copy of the TMDL will be provided on request, and the public is invited to provide comments on the TMDL.

7.0 INITIAL TMDL IMPLEMENTATION PLAN

This plan identifies applicable State-wide programs and activities that may be employed to manage point and nonpoint sources of selenium loads for the impaired stream segments in the Satilla River Basin. Local watershed planning and management initiatives will be fostered, supported, or developed through a variety of mechanisms. Implementation may be addressed by watershed improvement projects, assessments for Section 319 (h) grants, the local development of watershed protection plans, or "Targeted Outreach" initiated by EPD. These initiatives will supplement or possibly replace this initial implementation plan. Implementation actions should also be guided by the recommended management practices and actions contained within each applicable Regional Water Plan developed as part of Georgia's Comprehensive State-wide Water Management Plan implementation (Georgia Water Council, 2008).

7.1 Impaired Segments

This initial plan is applicable to the selenium impaired stream segments in the Satilla River Basin, which were added to Georgia's 303(d) list available on EPD's website (www.gaepd.org). The following table summarizes the descriptive information provided in the 303(d) list.

Water Bodies Listed for Selenium in the Satilla River Basin

Reach ID	Water body	Segment	County	Segment Length (miles)	Designated Use
GAR030702030202	Gibson Creek	Headwaters to the Turtle River (Brunswick)	Glynn	2	Fishing
GAR030702030203	Purvis Creek	Headwaters to the Turtle River	Glynn	2	Fishing
GAR030702030211	Brunswick River	South Brunswick River to the St. Simons Sound	Glynn	5	Fishing

Chapter 391-3-6-.03(5)(e)(ii) of Georgia's Rules and Regulations establishes criteria for selenium that apply to coastal and marine estuarine waters in the State. The established chronic criterion and acute criterion for dissolved selenium are as follows:

acute saltwater criteria for dissolved selenium = 290 µg/L
chronic saltwater criteria for dissolved selenium = 71 µg/L

These criteria are expressed in terms of the dissolved fraction in the water column. Exceedances of these criteria are violations of the water quality standards for selenium, and are the basis for adding a stream segment to the 303(d) listing.

7.2 Potential Sources

An important part of the TMDL analysis is the identification of potential source categories. A source assessment characterizes the known and suspected sources for selenium in the watershed. Sources are broadly classified as either point or nonpoint sources. A point source is defined as a discernable, confined, and discrete conveyance from that pollutants are or may be discharged to surface waters. Point sources of selenium may include discharges from wastewater treatment facilities and include storm water discharges through permitted storm water systems. Nonpoint sources of selenium are diffuse and cannot be identified as entering the water body at a single location. These sources may involve both natural processes and land use activities that contribute selenium to streams during rainfall events. Other potential nonpoint sources may exist such as deposition of particulates from air emissions and seepage of contaminated groundwater.

Currently, there are no NPDES permitted wastewater treatment facilities with permit limits that include selenium or selenium compounds discharging in the watersheds of the impaired stream segments. One industrial NPDES permitted facility is required to monitor for selenium in its discharge to the Brunswick River watershed. Potential nonpoint sources for selenium include natural processes comprised of the leaching of selenium from marine sediments in estuaries and tidal marshes, weathering of surface rocks and soils, and anthropogenic sources including non-permitted storm runoff from urban landscapes and industrial sites, runoff from improper disposal of waste materials, illicit discharges into storm sewer systems, leachate from operating and closed landfills, overflows from sanitary sewer lines, and leaking septic systems.

7.3 Management Practices and Activities

The NPDES permit program provides a basis for municipal, industrial, and storm water permits, monitoring and compliance with limitations, and appropriate enforcement actions for violations. In accordance with EPD rules and regulations, all discharges from point source facilities are required to be in compliance with the conditions of their NPDES permit at all times.

EPD is responsible for administering and enforcing laws to protect the waters of the State and is the lead agency for implementing the State's Nonpoint Source Management Program. Georgia is working with federal, county, and local governments, and other State and county agencies to foster implementation of BMPs that address nonpoint source pollution. The following management practices are recommended to reduce selenium loads to the impaired stream segments:

- Compliance with future NPDES treated wastewater permit requirements;
- Sustain compliance with NPDES MS4 permit requirements, where applicable;
- Sustain compliance with NPDES Industrial General Permit requirements, including where applicable, achieving benchmark levels for monitored constituents;
- Ensure storm water management plans are in place and being implemented by the local governments, and by the industrial facilities located in the watershed;

- Further develop and streamline mechanisms for reporting and correcting illicit discharges, breaks, surcharges, and general sanitary sewer system problems;

- Uphold requirements that all new and replacement sanitary sewage systems be designed to minimize discharges into storm sewer systems;

- Adoption of local ordinances (i.e. septic tanks, storm water, etc.) that address local water quality;

- Continue efforts to increase public awareness and education regarding the impact of human activities on water quality, ranging from industrial and municipal discharges to individual's activities in residential neighborhoods;

- Implement Erosion and Sedimentation Control Plans for land disturbing activities; and application of the *Manual for Erosion and Sediment Control in Georgia* (GSWCC, 2016);

- Continue working with Federal, State, and local agencies and owners of sites where cleanup measures are necessary, and in developing control measures to prevent future releases of constituents of concern;

- Implementation of recommended Water Quality management practices in the *Suwannee Satilla Regional Water Plan* (2017);

- Application of Best Management Practices (BMPs) appropriate to both urban and rural land uses, where applicable.

7.4 Monitoring

Elevated selenium concentrations have been observed at several locations in tidal streams and along Georgia's coast. Due to the limited amount of selenium data for this region, it has not been determined whether the observed levels for selenium are natural, or whether human activities are responsible. It is recommended that appropriate state agencies along with local governments and municipalities develop water quality monitoring programs to help pinpoint the sources of selenium, as well as verify the 303(d) water body listings. Following are recommendations for future monitoring:

1. Sampling should be continued on the three impaired stream segments at the same locations samples were previously collected. Additional monitoring sites should be established to include other tidal streams in the region. These sites should be located in the tidal zones and upstream from the tidal zones. Samples should be taken at high-standing tide and low-standing tide, and during both dry-weather and wet-weather events. Monitoring sites should also be established within St. Simons Sound, as rising tides feed into the Brunswick River system from the Sound. This additional sampling should provide a clearer picture as to what are typical selenium concentrations for these water bodies, how frequently the selenium water quality standards are exceeded, and may provide clues as to potential sources.

2. Water quality monitoring sites should be added to include areas further out from the coastline, on the ocean-side of St. Simons Island and Jekyll Island. These monitoring

locations may provide insight as to whether elevated selenium levels are limited to the estuaries, or if this is a common characteristic of the marine environment as a whole in this region.

3. Consider adding monitoring for selenium to the discharge and land application permits for coastal private, municipal, and industrial (where applicable) sanitary wastewater treatment systems that are located within the Brunswick River watershed. MS4 permits require that IWPs include monitoring of streams where outfalls are located within one mile of a 303(d) listed stream for the parameter causing the listing. Selenium was recently added to the parameters monitored for the Glynn County and City of Brunswick IWPs. This will provide information as to the significance of contributions of selenium from urbanized areas.

4. Selenium occurs naturally in sedimentary rock, shales, soils, and sediments. No sediment data for selenium could be found for the Brunswick River or for Gibson and Purvis Creeks. Sediment samples should be collected and analyzed for selenium from Brunswick River, Gibson Creek and Purvis Creek, and should include sediments from within the tidal zones, and upstream from the tidal zones. The sediments of St. Simons Sound should also be sampled since waters from the Sound feed into the Brunswick River system during rising tide. This sampling may indicate whether the sediments might be a source for the elevated selenium levels observed in the Brunswick River, Gibson Creek and Purvis Creek.

5. Marine organisms including plankton, shellfish, and fish have been shown to bioaccumulate selenium in body tissues, possibly resulting in the accumulation of selenium in the sediments of estuaries, tidal marshes, and tidal rivers where the organisms settle after they die. Consideration should be given to collecting organisms representing the different trophic levels in St. Simons Sound, Brunswick River, and Gibson and Purvis Creeks, and analyzing the tissues for selenium. Examining the presence of selenium at the different trophic levels may prove informative as to the significance of bioaccumulation in the overall presence of selenium in these water bodies.

These monitoring programs will also provide information towards determining if implementation of BMPs results in the improvement of water quality over time. EPD is available to assist in completing a monitoring plan, preparing a Sampling Quality Assurance Plan (SQAP), and/or providing necessary training as needed.

7.5 Future Action

This Initial TMDL Implementation Plan includes a general approach to pollutant source identification, as well as management practices to address pollutants. In the future, EPD will continue to determine and assess the appropriate point and non-point source management measures needed to achieve the TMDLs and to protect and restore water quality in impaired water bodies.

For point sources, any future wasteload allocations for wastewater treatment plant facilities will be implemented in the form of water-quality based effluent limitations in NPDES permits. Any wasteload allocations for regulated storm water will be implemented in the form of best management practices in the NPDES permits. Contributions of selenium from regulated communities may also be managed using information gained from permit required watershed

assessments, watershed protection plans, and long term monitoring. These measures will be directed through current point source management programs.

EPD will work to support watershed improvement projects that address non-point source pollution. This is a process whereby EPD and/or Regional Commissions or other agencies or local governments, under a contract with EPD, will develop a Watershed Management Plan intended to address water quality at the small watershed level (HUC 10 or smaller). These plans will be developed as resources and willing partners become available. The development of these plans may be funded via several grant sources, including but not limited to, Clean Water Act Section 319(h), Section 604(b), and/or Section 106 grant funds. These plans are intended for implementation upon completion.

Any Watershed Management Plan that specifically address water bodies contained within this TMDL will supersede the Initial TMDL Implementation Plan once EPD accepts the plan. Future Watershed Management Plans intended to address this TMDL and other water quality concerns, written by EPD and for which EPD and/or the EPD Contractor are responsible, will contain at a minimum the USEPA's 9 Elements of Watershed Planning:

1) An identification of the sources or groups of similar sources contributing to nonpoint source pollution to be controlled to implement load allocations or achieve water quality standards. Sources should be identified at the subcategory level with estimates of the extent to which they are present in the watershed (e.g., X numbers industrial sites needing upgrading, Y acres of contaminated soils needing remediation, or Z linear miles of eroded stream bank needing restoration);

2) An estimate of the load reductions expected for the management measures;

3) A description of the NPS management measures that will need to be implemented to achieve the load reductions established in the TMDL or to achieve water quality standards;

4) An estimate of the sources of funding needed, and/or authorities that will be relied upon, to implement the plan;

5) An information/education component that will be used to enhance public understanding of and participation in implementing the plan;

6) A schedule for implementing the management measures that is reasonably expeditious;

7) A description of interim, measurable milestones (e.g., amount of load reductions, improvement in biological or habitat parameters) for determining whether management measures or other control actions are being implemented;

8) A set of criteria that can be used to determine whether substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether the plan needs to be revised; and;

9) A monitoring component to evaluate the effectiveness of the implementation efforts, measured against the criteria established under item 8.

The public will be provided an opportunity to participate in the development of Watershed Management Plans that address impaired waters and to comment on them before they are finalized.

EPD will continue to offer technical and financial assistance (when and where available) to complete Watershed Management Plans that address the impaired water bodies listed in this and other TMDL documents. Assistance may include but will not be limited to:

- Assessments of pollutant sources within watersheds;
- Determinations of appropriate management practices to address impairments;
- Identification of potential stakeholders and other partners;
- Developing a plan for outreach to the general public and other groups;
- Assessing the resources needed to implement the plan upon completion; and
- Other needs determined by the lead organization responsible for plan development.

EPD will also make this same assistance available, if needed, to proactively address water quality concerns. This assistance may be in the way of financial, technical, or other aid and may be requested and provided outside of the TMDL process or schedule.

REFERENCES

Baginska, B., T. 2015. *Total Maximum Daily Load Selenium in North San Francisco Bay. Draft Staff Report.* California Regional Water Quality Control Board, San Francisco Bay Region. Oakland, CA.

Federal Register, 1990. *Federal Register, Part II: Environmental Protection Agency*, Vol. 55, No. 222, November 16, 1990.

EPA, 1996. *The Metals Translator: Guidance For Calculating A Total Recoverable Permit Limit From A Dissolved Criterion*, Office of Water, EPA 823-B-96-007, June 1996.

EPD, 2002. *Satilla River Basin Management Plan 2003,* State of Georgia, Department of Natural Resources, Environmental Protection Division, Water Protection Branch.

EPD, 2020. *Water Quality in Georgia,* 2018-2019, Georgia Department of Natural Resources, Environmental Protection Division.

EPD, 2019. *Georgia Statewide Nonpoint Source Management Plan – FFY 2019 Update*, Georgia Department of Natural Resources, Environmental Protection Division, Watershed Protection Branch.

EPD, 2021. *State of Georgia Rules and Regulations for Water Quality Control, Chapter 391-3-6,* State of Georgia, Department of Natural Resources, Environmental Protection Division, Water Protection Branch.

EPD, 2020. *Permitted Surface Mining Facilities,* State of Georgia, Department of Natural Resources, Environmental Protection Division, Land Protection Branch, Surface Mining Unit. January 2020.

EPD, 2017a. *Personal Communications*, State Geologist, Georgia Department of Natural Resources, Environmental Protection Division, Directors Office, June 2017.

EPD, 2017b. *Personal Communications*, Stormwater Unit, Georgia Department of Natural Resources, Environmental Protection Division, Directors Office, June 2017.

Georgia Water Council, 2008. Georgia Comprehensive State-wide Water Management Plan, Atlanta, Georgia, January 2008.

GSWCC, 2016. *Manual for Erosion and Sediment Control in Georgia, 2016 Edition,* Georgia Soil and Water Conservation Commission, Athens, Georgia, 2016.

Lemly, A., 2000. *Guidelines for conducting TMDL Consultations on Selenium*. U.S. Forest Service, Southern Research Station. Blacksburg, VA. May 2000.

Luoma, S. and Presser, T. 2009. *Emerging Opportunities in Management of Selenium Contamination.* Environmental Science and Technology. Vol. 43.

NOAA, 2017. *Water Temperature Table of all Coastal Regions.* National Centers for Environmental Information. National Oceanic and Atmospheric Administration. Washington, D.C.

Reeder, T. and Schneider, J. 2009. *Total Maximum Daily Loads and Site-Specific Objectives for Selenium in the Newport Bay Watershed, Orange County, California. Draft Technical Staff Report.* Santa Ana Region Water Quality Control Board, Riverside, CA.

Saliminen, R., et. al., 2005. *Geochemical Atlas of Europe. Part 1: Background Information, Methodology and Maps.* Geologic Survey of Finland, Espoo, Finland.

Santiago, A., et. al., 2014. *Characterization of Selenium in Ambient Aerosols and Primary Emission Sources.* Environmental Science and Technology. Vol. 48.

Suwannee-Satilla Regional Council, 2017. *Suwannee Satilla Regional Water Plan*, Atlanta, Georgia, Adopted by EPD November 2017.

Tetra Tech, Inc., 2008. *Technical Memorandum 2: North San Francisco Bay Selenium Data. Summary and Source Analysis.* Regional Water Quality Control Board, San Francisco Bay Region, Oakland, CA. July 2008.

USEPA, 1991. *Guidance for Water Quality Based Decisions: The TMDL Process*, EPA 440/4-91-001, U.S. Environmental Protection Agency, Assessment and Watershed Protection Division, Washington, D.C.

USEPA, 1994. *Water Quality Standards Handbook (Appendix J):* Second Edition, U.S. Environmental Protection Agency, Office of Water, EPA 823-B-94-005a, June 1996.

USEPA, 2004. *National Recommended Water Quality Criteria.* U.S. Environmental Protection Agency, Office of Water, 4304T.

USEPA, 2007. TOTAL Maximum Daily Loads for Metals and Selenium San Gabriel River and Impaired Tributaries. USEPA Region 9. San Francisco, CA. March 2007.

USEPA, 2016. *Aquatic Life Ambient Water Quality Criterion for Selenium in Freshwater 2016.* U.S. Environmental Protection Agency, Office of Water, EPA 822-R-16-006, June 1996.

Utah Department of Environmental Quality, 2013. *TMDL for Selenium in the Colorado River Watershed.* Division of Water Quality. Salt Lake City, UT.